Purpose: For dosimetric and research irradiation studies, we have implemented a Monte Carlo (MC) dose computation model based on the physical and radiological characteristics of the Gamma Knife Perfexion (GK PFX) using the Penelope MC dosimetry codes. GK dosimetric aspects examined include: 1) output factors (OF) for each of the three GK collimator sizes (4, 8, 16 mm), 2) OFs for each source row and collimator size, and 3) dose distribution profiles.
Methods: Vendor proprietary information facilitated our modeling of the GK PFX irradiation geometry, which was mathematically defined within Penelope. MC simulations were carried out on a Linux cluster. 3D dose distributions were analyzed using Matlab. A 16 cm diameter dosimetry sphere was modeled with a virtual detector volume at its center. Detector volume varied from 33 to 590 mm^3 to study detector volume effects. A single source per row was modeled for five rows for each collimator (15 beams modeled). Single-source dose distributions were rotated about the z-axis of the axially symmetric geometry and summed to simulate all 192 sources.
Results: Good agreement is found for row- and total-output factors (greatest deviation <2% for the 4 mm collimator) compared to reference values. Simulated and measured full-width at half-max values of 3D dose distribution profiles show sub-millimeter differences (0.4 mm, 4 and 8 mm collimators; 0.9 mm, 16 mm collimator). There is excellent agreement for integrated profile shapes.
Conclusions: Detailed geometric representations (radiation source, device components) of the GK PFX are required for high fidelity MC simulations. Calculated GK PFX OF values are dependent on the simulated detector volume size (4 mm OF most dependent). Our model shows strong agreement for the GK PFX OFs and dose profile shapes compared to reference values.

Funding Support, Disclosures, and Conflict of Interest:

Acknowledgement: Non-disclosure agreement for proprietary information with Elekta AB. No financial contribution.